

CAREX INVERSA R. BR. (CYPERACEAE), NEW TO HAWAII AND THE UNITED STATES

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ABSTRACT

Carex inversa R. Br., a rhizomatous perennial species endemic to Australia and New Zealand, is reported for the first time from the Hawaiian Archipelago. The taxon was discovered in an area known as the Kipuka Alala near the center of the island of Hawaii at an elevation of approximately 1675 m (5500 ft). The species occurs in *Styphelia* Mixed Shrubland, Dense *Dodonaea* Shrubland, and Sparse *Metrosideros* Montane Treeland plant communities. Two other introduced Australian species [*Lepidium hyssopifolium* Desv. and *Crassula sieberiana* (Schult.) Druce] are restricted to the same general area as *Carex inversa*. The occurrence of the taxon probably represents an inadvertent introduction by domestic livestock or in grass seed mixtures. Long distance transport by wind or birds is another possible but highly improbable mode of introduction for the species. Rather large clones, some up to 4 m in diameter, and occurrence of the taxon in several diverse habitats suggests that the original introduction may not be recent.

KEY WORDS: *Carex*, Hawaii, Australia, New Zealand, introduction

The first taxonomic revision of the *Carex* of the Hawaiian Islands listed nine species which were all thought to be native (Krauss 1950). The most recent revision of the carices recognizes eight species from the Islands (Koyama 1990); however, only four species are listed as endemic and four are indigenous. The geographic affinities for the indigenous species are: one with Eurasia, one with Europe and Pacific North America, one with the Caroline Islands, and one possibly with eastern Asia.

Carex inversa R. Br. (Figures 1, 2), commonly known as knob sedge, is being reported for the first time from the Hawaiian Islands. This taxon is a member of subgenus *Vignea* and section *Inversa*. It is a perennial herb (0.25-0.75 m high) that occurs frequently in clonal swards because of its spreading rhizomes. Culms are slender and leaves are basal as well as cauline. The leaf blades are linear (1-4 mm wide) and involute at the tip. The leaf sheaths tightly clasp the stem and project beyond the juncture with the blade producing a membranous appendage (contraligule). The gynecandrous inflorescence is composed of 2-3(-4) short, ovoid terminal spikes (5-15 mm long). The lowermost spike is subtended by leaf-like involucre

bracts, at least one of which surpasses the entire inflorescence. Each perigynium is subtended by an ovate, short-awned scale (2.0-3.0 mm long). The midribs of the scale are prominent and pale green, and margins are broad, translucent and entire. Male flowers have 3 stamens (1.9-2.1 mm long), and the anthers are 2-celled (1.1-1.6 mm long, including the anther hairs) with numerous basally-fused hairs present at the anther's apex. Female flowers are comprised of a single pistil with 2 stigmas. The pistil is contained within a beaked perigynium (~ 3 mm long) and the branches extrude from a small bifid orifice at the apex. The perigynium is slightly winged above the middle, and the margin is finely serrate. Abaxial and adaxial faces are strongly veined (9-11 and 6-8, respectively). The achene is flattened, lenticular and reaches ~ 2 mm in length at maturity. Our collections were verified by comparison with specimens from Australia (US 31117, 1349954, 2072356, 2072359, 2072373, 2126591, 3165854) and New Zealand (US 1239957, 3165853, 3165855, 3203467) at the US National Herbarium and by Drs. Anton A. Reznicek (University of Michigan) and Karen Wilson (New South Wales Herbarium). Bentham (1878), Moore & Edgar (1970), and Black (1978) all listed varieties for *C. inversa*; however, most recent usage suggests that separation into intraspecific categories is unwarranted without further study.

Carex inversa grows in the Australian states of Queensland, New South Wales, Victoria, Tasmania, South Australia, and West Australia. The taxon also is reported from both the North and South Islands of New Zealand. Burbidge & Gray (1970) described the plant as a weedy sedge which forms dense patches or swards in poorly sown or modified natural grasslands. In New Zealand tussock grassland communities, *C. inversa* grows in association with *Poa caespitosa* Spreng., *Festuca novae-zealandiae* (Hack.) Cockayne, *Danthonia gracilis* Hook., *Danthonia unarede* Raoul, and *Dichelachne crinita* (L.) Hook. (Cockayne 1967). Burbidge & Gray (1970) and Beadle *et al.* (1972) reported the species from *Eucalyptus* woodlands and swampy areas or creek banks. Within its range, the taxon is relatively common and widespread in mesic sites of localized communities. Healy & Edgar (1980) reported that *C. inversa* is a troublesome weed in lawns, paths, and rockeries. Because of its rhizomatous habit, *C. inversa* may be invasive and difficult to eradicate (Willis 1962). It appears to be tolerant of grazing and may be of value in providing a limited amount of fair quality forage when it occurs in quantity (Leigh & Malham 1965). The plant also appears to be resistant to trampling and mowing.

Carex inversa was discovered during floristic inventories on the Pohakuloa Training Area (PTA), Hawaii (Figure 3). PTA is the largest U.S. Army installation in Hawaii, over 43,700 ha (108,000 ac) in size, and is situated in the saddle between two volcanoes (Mauna Kea and Mauna Loa) which are over 4200 m (13,800 ft) in elevation. Approximate average annual precipitation for the saddle area is 39 cm (15 in) [data from Bradshaw Army Airfield which is 14 km (9 mi) northeast and 200 m (650 ft) higher in elevation than the collection sites for *C. inversa*]. Substrate on the installation is composed of numerous younger (<10,000 year old) Mauna Loa lava flows and some older (>10,000 year old) Mauna Kea flows. The diversity in lava substrates combined with the fairly wide altitudinal gradient gives rise to a complex mosaic of plant communities. Castillo *et al.* (1994) have delineated 24 plant communities on the installation. Shaw & Douglas (1995) have documented ten endangered or threatened species, five Category 2 candidate species, and one presumed extinct species on the installation. *Carex wahuensis* C.A. Mey. subsp. *wahuensis* and subsp. *rubiginosa* (R. Krauss) T. Koyama are the only other members of the genus found on the installation.



FIGURE 1. *Carex inversa* R. Br. (Douglas et al. 4618) a. general habit illustrating extensive rhizome development, b. inflorescence composed of three spikes, and c. single gynecandrous spike

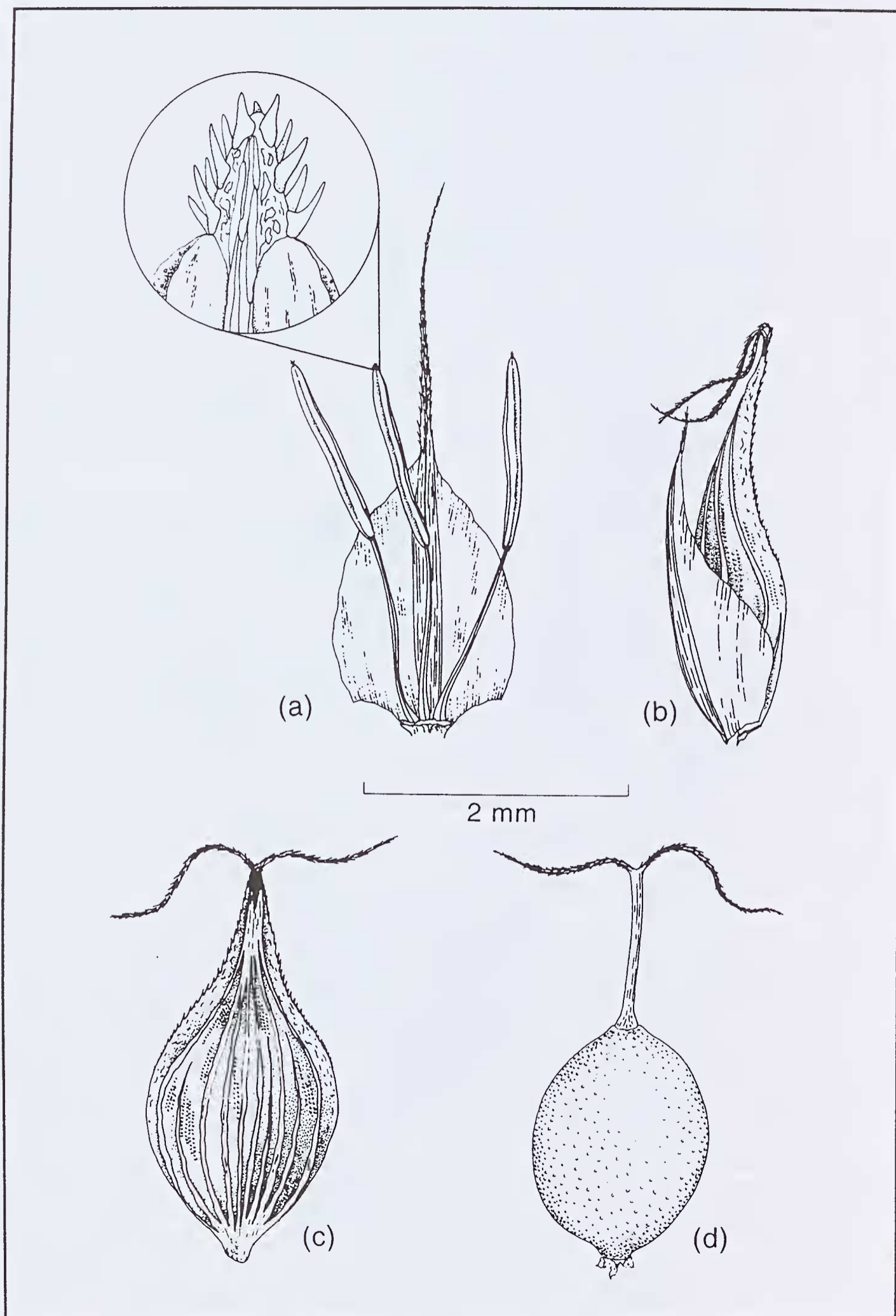


FIGURE 2. *Carex inversa* R. Br. (Douglas et al. 4618) a. Male flower with insert showing terminal anther hairs, b. perigynium with bract, c. abaxial face of the perigynium, and d. lenticular achene

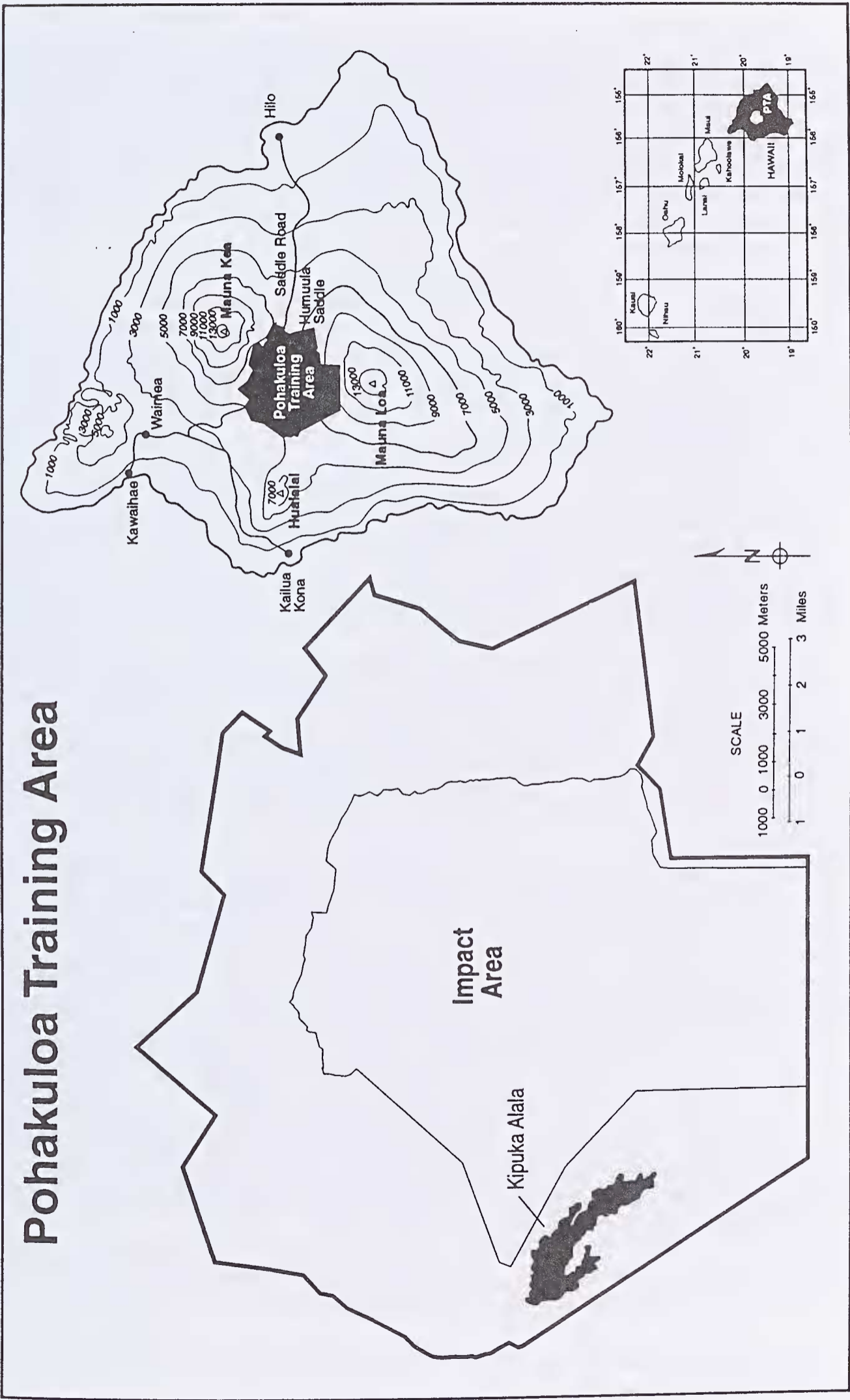


FIGURE 3. Location of Kipuka Alala in the southwest portion of Pohakuloa Training Area on the island of Hawaii, Hawaii.

Carex inversa was first collected near and in Kipuka Alala, on the southwestern portion of the installation (Figure 2) (Douglas *et al.* 3507 [MICH], 3508 [BISH], 4612 [CS], 4618 [CS], 5045 [RM], 5048 [CS]). A kipuka is an older and more heavily vegetated lava flow that is surrounded and isolated by younger flows with sparser vegetation. Kipuka Alala is approximately 1750 ha (4325 ac) in size and the substrates are Mauna Loa lavas ranging in age from 1500 to > 4000 years old (Lockwood *et al.* 1988). Vegetation within Kipuka Alala consists of *Dodonaea*, *Styphelia*, and *Myoporum* dominated shrublands (Castillo *et al.* 1994). Adjoining younger flows (< 1500 years old) support open *Metrosideros* treelands.

Carex inversa is rare to scattered in the following plant communities: *Styphelia* Mixed Shrubland, Dense *Dodonaea* Shrubland, and Sparse *Metrosideros* Treeland (Castillo *et al.* 1994). Plants occur in soil and/or ash accumulations which are slightly more mesic than the surrounding landscape. The taxon generally grows in full sun. Plants were observed flowering during the wet period of the year (November to February), which differs from the flowering period for Australian and New Zealand populations (October to April) (Marchant *et al.* 1987). Plants grazed by feral sheep and/or goats were seen; however, no adverse effects of grazing were noticed.

A vascular plant survey of the installation documented 249 species growing on PTA (Shaw & Douglas 1995). Approximately 61% (157 species) of these taxa are naturalized. Nineteen taxa are introduced species from Australia and/or New Zealand. Three Australian introduced grass species [*Danthonia pilosa* R. Br., *Ehrharta stipoides* Labill., and *Eragrostis brownei* (Kunth) Nees *ex* Steud.] are common within the area.

There are two other examples of Australian or New Zealand species introduced only into the saddle area and PTA (Shaw & Douglas 1995; Wagner *et al.* 1990). *Lepidium hyssopifolium* Desv. (Brassicaceae) was first found in 1975 in the saddle area and was known from only two collections until recently verified from PTA (Wagner *et al.* 1990). *Crassula sieberiana* (Schult.) Druce (Crassulaceae) is a widespread interstitial species throughout the installation. Wagner *et al.* (1990) reported that this taxon was first collected in 1978 and apparently was a recent introduction.

Several explanations exist for the occurrence of these Australian species only in the saddle region of the island of Hawaii. First, a single natural event may have brought the species to the saddle area (*i.e.*, storm or birds). Second, the species were introduced by humans in forage seed mixtures, by herds of grazing animals, or by military vehicles. Third, the introduction of these taxa may be completely unrelated and represent separate events. Prior to the mid 1970's, relatively few introduced taxa were reported from the saddle region which suggests the region was either still fairly pristine at this time or poorly collected. If the former is true, then the Australian species may indeed be rather recent introductions. Conversely, the large clones indicate that *Carex inversa* may have occurred at PTA before this date. Studies are ongoing to examine the genetic variability throughout the species and to determine similarities between Hawaiian and Australian/New Zealand material. These data should help determine the origin of the Hawaiian populations as well as the approximate time of introduction.

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